YOUR TASK

You need to design a control system for a batch process in which a liquid at room temperature ($20^{o}C$) is pumped into a tank until a given level is reached, then the liquid is heated and mixed, after which is evacuated. The following control system design specifications must be satisfied:

➢ The system will work in five
   different states: IDLE:
   • Begins when the program is started, or a cycle is completed (a low-level limit switch stops detecting the liquid).
   • Ends when the START button is pressed or when alarm conditions trigger the FAULT state.
   • Actuates the IDLING lamp for indicating purpose.
   FILL:
   • Begins when the START button is pressed in the IDLE state.
   • Is a permissive for the pump.
   • Ends when liquid reaches the pre-set level or when alarm conditions trigger the FAULT state
   • Actuates the FILLING lamp for indicating purpose.
   HEAT & MIX:
   • Begins when the pre-set liquid level is reached in the FILL state.
   • Is a permissive for the agitator and the servo-valve controlling the steam supply to a heater.
   • The servo-valve opens by 10% every 5 seconds, then remains fully open until the temperature of the liquid in the tank reaches $90^{o}C$, at which point it shuts off.
   • Ends when the temperature of the liquid in the tank reaches $90^{o}C$ or when alarm conditions trigger the FAULT state.
   • Actuates the HEATING & MIXING lamp for indicating purpose.
   EMPTY:
   • Begins when the temperature of the liquid in the tank reaches $90^{o}C$ in the HEAT & MIX state or when alarm conditions are reset in the FAULT state.
   • Is a permissive for the solenoid valve.
   • Ends when a low-level limit switch stops detecting the liquid or when alarm conditions trigger the FAULT state.
   • Actuates the EMPTYING lamp for indicating purpose.
   FAULT:
   • Begins when a high-level limit switch is triggered or when the STOP button is pressed.
   • Ends when the RESET button is pressed.
   • Actuates the ALARM lamp for indicating purposes.
➢ The pump
   • speed is controlled by a PID controller, which can also correct for variations in the liquid level in the HEAT & MIX state caused by opening the manual valve, and
   • must be programmed with an interlock to ensure that it stops if the solenoid valve is open.
➢ The HEAT & MIX state is not physically realised, only modelled by assuming a linear increase in temperature, with the rate of increase proportional to the opening of the servo-valve.
➢ Controls and indicators must be implemented:
   • via field devices for *Manual* operation, and
   • on the SCADA page for *Automatic* operation.
➢ You need to use at least two different Control Expert programming languages.
➢ As a reflection of the industry practice which seeks to minimize the risks and hazards involved in running an actual plant, first design and validate your control solution by using the *Discrete I/O simulator and interface*.